the snow cover at the close of January was less extensive and deep than for a similar date in any other year of which we have records. The run-off during January was light and streams were unusually low. While the water supply is adequate in central and northern counties, there is some apprehension in other sections.

January, 1912, stands in marked contrast with January, 1911, which was a month of unusually heavy precipitation in all parts of California. The snow cover then was extensive and deep. This condition followed a long dry period which was not broken until January 9.

Summit.—The following table shows the depth of snow on the ground at Summit, Cal., on certain dates in January during the period 1907 to date:

	Jan. 1.	Jan. 15.	Jan. 31.
	Inches.	*Inches.*	*Inches.*
1907	45	142	148
1908	87	72	87
1909	28	90	172
1910	54	87	68
1911	4	136	218
1912	60	46	41

SUNSHINE.

The following table gives the total hours of sunshine and percentages of the possible:

Station.	Hours.	Percentage of possible.	Station.	Hours.	Percentage of possible.
Eureka	60	20	Sacramento	91	30
Fresno	146	47	San Diego	235	74
Los Angeles	232	73	San Francisco	114	37
Mount Tamalpais	91	30	San Jose	174	55
Red Bluff	108	36	San Luis Obispo	140	45

There was much more sunshine in the southern counties than during January, 1911, but less in the northern counties.

CHANGES IN NAMES OF STATIONS.

The following changes have been made in the names of stations, and the new names are used beginning with the present issue:

Brush Creek changed to Stanwood.
Daunt changed to Springville.
Nimshew changed to De Sabla.
Pollasky changed to Friant.

NOTES ON THE RIVERS OF THE SACRAMENTO AND SAN JOAQUIN WATERSHEDS FOR JANUARY, 1912.

By N. R. TAYLOR, Local Forecaster.

SACRAMENTO WATERSHED.

The stages of the rivers of this watershed averaged from 1 foot to slightly over 2 feet above those of the preceding month. They were, however, unprecedentedly low for the season. With the exception of the record at Red Bluff, in 1902, when extreme low water for the month was reached, previous low-water records were broken in the drainage basin of the Sacramento Valley.

The following data from selected points in the Sacramento watershed show river conditions during January: Kennett, 3.2 feet, 2.0 feet below the normal; Red Bluff, 3.7 feet, 3.1 feet below the normal; Colusa, average 5.6 feet, 7.6 feet below normal; Knights Landing, average 3.6 feet, 8.5 feet below normal; Sacramento City, average 8.1 feet, 8.6 feet below the normal; Folsom, 3.1 feet, 3.1 feet below the normal; Oroville, average 2.7 feet, 2.5 feet below the normal; Marysville, average 7.2 feet, 3.4 feet below the normal.

The first general rise during the season of any importance occurred during the last decade of the month. Coincident with the heavy rains in the upper part of the Sacramento Valley the river at Kennett rose 5 feet during the 24 hours ending at 7 a. m. of the 26th, when a stage of 13.5 feet was recorded. The crest of this rise reached Colusa on the 27th, and Knights Landing and Sacramento City on the 28th.

The rise below Monroeville was greatly augmented by the output of Stony Creek, which, on the 26th, rose nearly 9 feet in less than 24 hours. The highest stage reached on the Sacramento River was 21.9 feet at Colusa at 4 p. m. of the 26th.

Although the rainfall in the watersheds of the American, Feather, and Yuba Rivers was much less than in the upper reaches of the Sacramento, sharp rises occurred in those streams, the greatest of which was 5 feet at Oroville on the Feather River.

By the last of the month the rivers were falling, and the upper Sacramento and many of the smaller watercourses were rapidly approaching the extreme low-water stages that prevailed previous to the rain.

The rainfall in all sections of the Sacramento drainage area was deficient, especially so in the foothill regions and along the west slopes of the Sierra.

SAN JOAQUIN WATERSHED.

The average stages of all rivers in this watershed varied only slightly from those of the preceding month, and were from 1 to 5 feet below the January normal. With few exceptions all streams were the lowest ever before known during the month in question.

While the rainfall throughout the San Joaquin Valley was deficient the normal was more closely approached than in that of the Sacramento. But its effect on the rivers was not appreciable in the San Joaquin between Friant and Firebaugh, nor in the Merced, and barely so in the San Joaquin below the mouth of the Stanislaus. The Tuolumne, Mokelumne, Cosumnes, Stanislaus, and Calaveras Rivers rose slightly, the rises ranging from 1 to somewhat over 2 feet.

A STUDY OF DRY SEASONS IN SAN DIEGO.

By FORD A. CARPENTER, Local Forecaster.

Considerable apprehension has been felt as to the outcome of the present season in San Diego as regards rainfall. Twelve years ago similar conditions prevailed, and in the Monthly Weather Review of January, 1900, the editor discussed the light rainfall in San Diego, concluding with this statement:

> It would, however, seem that there is little likelihood that the rainfall for the season 1899–1900 will be smaller than four inches, so that the three seasons just past will represent nothing worse than has happened twice before in 10 years, namely, between 1855 and 1860, and between 1869 and 1872.[1]

The seasonal rainfall for 1899–1900 was 5.97 inches or 1.97 inches more than the estimated amount.

A perusal of the accompanying table will show that while the rainfall to date has been scanty it does not indicate that the balance of the season will be likewise dry. During the past 62 years San Diego has experienced

[1] Monthly Weather Review, Vol. XXVIII, pp. 20-21.

6 other years when the rainfall was less than that which has fallen so far this season. The record of these dry seasons is most instructive as it gives us the only indication of what may be expected in the way of rain for the next few months. The examination of average conditions is rarely satisfactory for the reason that the normal seldom if ever occurs. It is the exception that generally happens; and with this fact in view the following table has been compiled from the long rainfall record at this station. Only those seasons which resemble the present one have been considered.

Rainfall at San Diego, Cal.—Number of seasons in 62 years where less than half the normal was received up to Jan. 31.

Years.	Months.				Total, Oct. 1–Jan. 31.	Months.				Total, Oct. 1–May 31.
	Oct.	Nov.	Dec.	Jan.		Feb.	Mar.	Apr.	May.	
1863–64	0.0	0.73	0.04	0.04	0.81	2.50	0.20	0.01	1.25	4.77
1872–73	.0	.0	1.43	.44	1.87	4.21	.11	.10	.03	6.32
1876–77	.08	.04	.15	1.05	1.32	.18	1.44	.26	.43	3.63
1882–83	.41	.39	.13	1.09	2.02	.95	.41	.31	1.14	4.83
1886–87	.05	.95	.10	.04	1.14	4.51	.02	2.14	.47	8.28
1899–1900	.35	.86	.65	.69	2.55	.03	.53	1.26	1.45	5.82
1901–2	.28	.41	.02	1.70	2.41	1.57	1.86	.21	.06	6.11
1903–4	.07	.0	.35	.04	.46	1.50	2.17	.15	.12	4.40
1911–12	.28	.0	1.39	.66	2.33	.....	.....	.....	.....	.....
Means	.17	.38	.47	.64	1.66	1.93	.84	.56	.62	5.52

The season of least rainfall, that of 1876–77, showed less precipitation than any of the previous 27 years, and nothing has approached it in the 35 years that have elapsed. The history of that season shows that the last rain occurred on March 9, 1876, and until January 13 of the following year a total of only 0.65 of an inch was recorded. There appears to have been no damage to the orchards or inconvenience to other local interests, as the water storage was ample for all needs at that time. After this 10 months' drought nearly 3½ inches of rain fell.

It will be observed that February 1 marks the middle of the rainy season in San Diego. During a normal year 5 inches of rain falls after this date. In a dry year, like the present, the records show that nearly 4 inches of rain is liable to fall between this date and the end of May.

Normal rainfall by months.—September, 0.06 inch; October, 0.46 inch; November, 0.83 inch; December, 1.82 inches; January, 2 inches; February, 1.96 inches; March, 1.70 inches; April, 0.74 inch; May, 0.41 inch; June, 0.03 inch; July, none; August, none; year, 10.01 inches.

During the dry seasons referred to above the February rainfall averages 1.93 inches, generally falling in a few sharp showers accompanied by brisk to high southwesterly winds. In the cases where the March rainfall is considerable, like the years 1877 and 1904, the showers are more widely scattered. In fact, the records of the weather in San Diego during droughty periods indicate that downpours are common in February and occur during northerly storms, while March and April rains frequently result from southerly storms. During May the rains are largely of the "Sonora" type, being overflows from the Arizona disturbances. Rains from such storms often follow dense fogs. The character of the weather during seasons of light rainfall is very distinct and constitutes a class by itself, as shown by the pressure, temperature, winds, humidity, etc., which have been examined for each of these individual seasons. The records of the last few dry seasons have been studied in connection with the daily weather map and there is found to be a striking similarity in the distribution of the pressure areas. The past seasons resemble the present in that the widespread high areas are persistent and greatly outnumber the lows in their frequency, and the former possess far more energy. While it is impossible to make seasonal forecasts, a perusal of the tables which accompany this article would indicate that there is little likelihood of San Diego experiencing a severe drought, but that, on the contrary, there is every reason to believe that this region will receive not less than 3 or 4 inches more of rain during this season.

STUDIES IN FROST PROTECTION—EFFECT OF MIXING THE AIR.

By A. G. McADIE.

In a bulletin on Frost Fighting (Bulletin No. 29) issued by the Weather Bureau in 1900, three general principles were enumerated as effective in preventing frost. These were: 1, adding heat; 2, saving heat; 3, mixing or stirring the air.

By the direct addition of heat through such devices as coal baskets, fuel pots, and other orchard heaters of various types, much successful work has been done in raising the temperature in fruit orchards during critical times and thus preventing injury and subsequent loss.

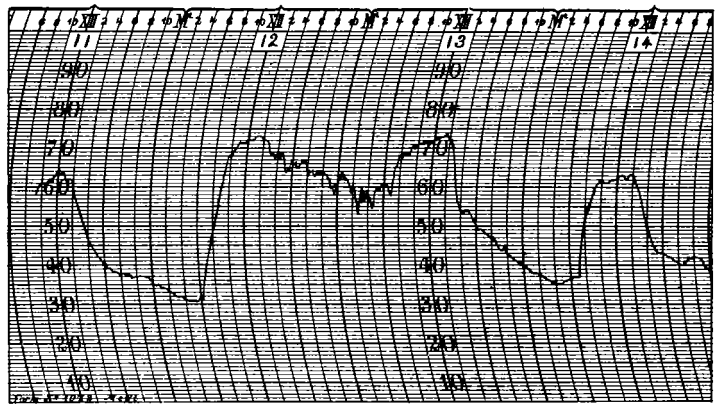

FIG. 1.—Temperature fluctuations at Kentfield, Cal., during period favorable for frost, Dec. 11–14, 1911.

Along the second line, that of saving he at, some work has been done in designing suitable covers. Much, however, remains to be done, and the problem of conserving the heat of the earth, plants, and the lower air is yet in an experimental stage. In many respects this is the cleanest and most efficient method of protecting.

Along the third line, that of mixing or stirring the air, suggestions have been made from time to time that windmills or electric fans could be arranged to insure circulation and prevent the formation of stagnant pools of air. In Farmers' Bulletin No. 104, issued November 27, 1911, the writer states on page 27 that so far as known no special devices suitable for commercial use in frost protection had been developed, making use of this principle of thorough ventilation:

> When nature mixes the air, i. e., on windy nights, frost does not occur. It is now known to meteorologists that layers of air of different temperatures may lie close to each other without mixing. On frosty nights there is often a difference of 6, 8, or 10° in temperature between the ground and the air 10 feet above, the warmer layers being uppermost. Where air is well mixed and there is good circulation, we seldom find frost.

An interesting illustration of the effect of stirring the air and the consequent prevention of low night and early morning temperatures is given by the accompanying thermograph record made at Kentfield, Cal., December 11 to 14, 1911. This is the base station for Mount Tamal-